

Generation of neutrino interactions with GENIE: Tabulated statistics in different channels

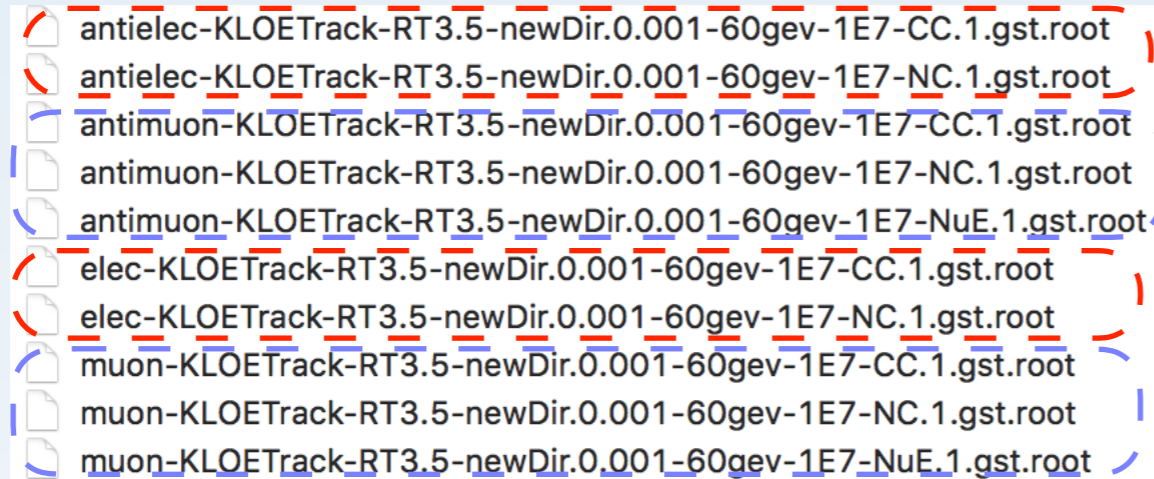
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Introduction

- Neutrino generator: GENIE v2.12.8.
- Geometry: KLOE magnet filled with STT. Corrected geometry by M Kordosky and M Tenti, ν flux along z-axis, KLOE symmetric along x-axis.
- Interactions produced in the tracking region only, to increase statistics.
- 10^7 events for each file generated flat in log E in the region 1 MeV \div 60 GeV, weighted to the official ν flux in neutrino mode (FHC) and **antineutrino mode (RHC)** for DUNE ND — see also <http://home.fnal.gov/%7EIJf26/DUNEFluxes/>
- Separate files are produced according to the following scheme:
 - muon and electron neutrinos and antineutrinos, CC and NC (8 files);
 - muon neutrinos and antineutrinos, electron interactions (2 files).

Neutrino interactions and simulated files

- In total, 10 files are generated:



$(\bar{\nu}_\mu)$

$(\bar{\nu}_e)$

- CC includes the followings:

- | | |
|--------------------------------------|---------------------------|
| - genie::EventGenerator/QEL-CC | Quasi-elastic scattering |
| - genie::EventGenerator/RES-CC | Resonant production |
| - genie::EventGenerator/DIS-CC | Deep-inelastic scattering |
| - genie::EventGenerator/COH-CC | Coherent |
| - genie::EventGenerator/DIS-CC-CHARM | DIS with charm |
| - genie::EventGenerator/QEL-CC-CHARM | QEL with charm |

- NC includes:

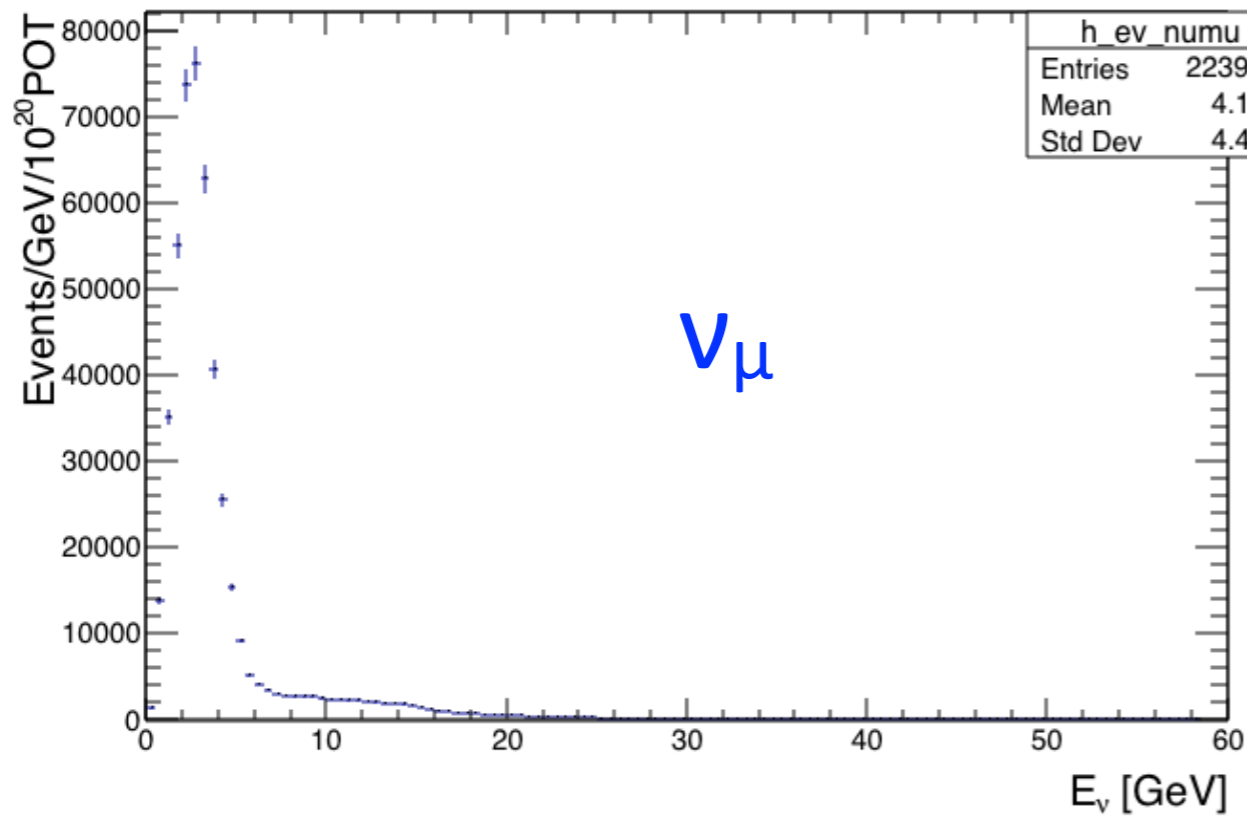
- genie::EventGenerator/QEL-NC
- genie::EventGenerator/RES-NC
- genie::EventGenerator/DIS-NC
- genie::EventGenerator/COH-NC

- NuE includes:

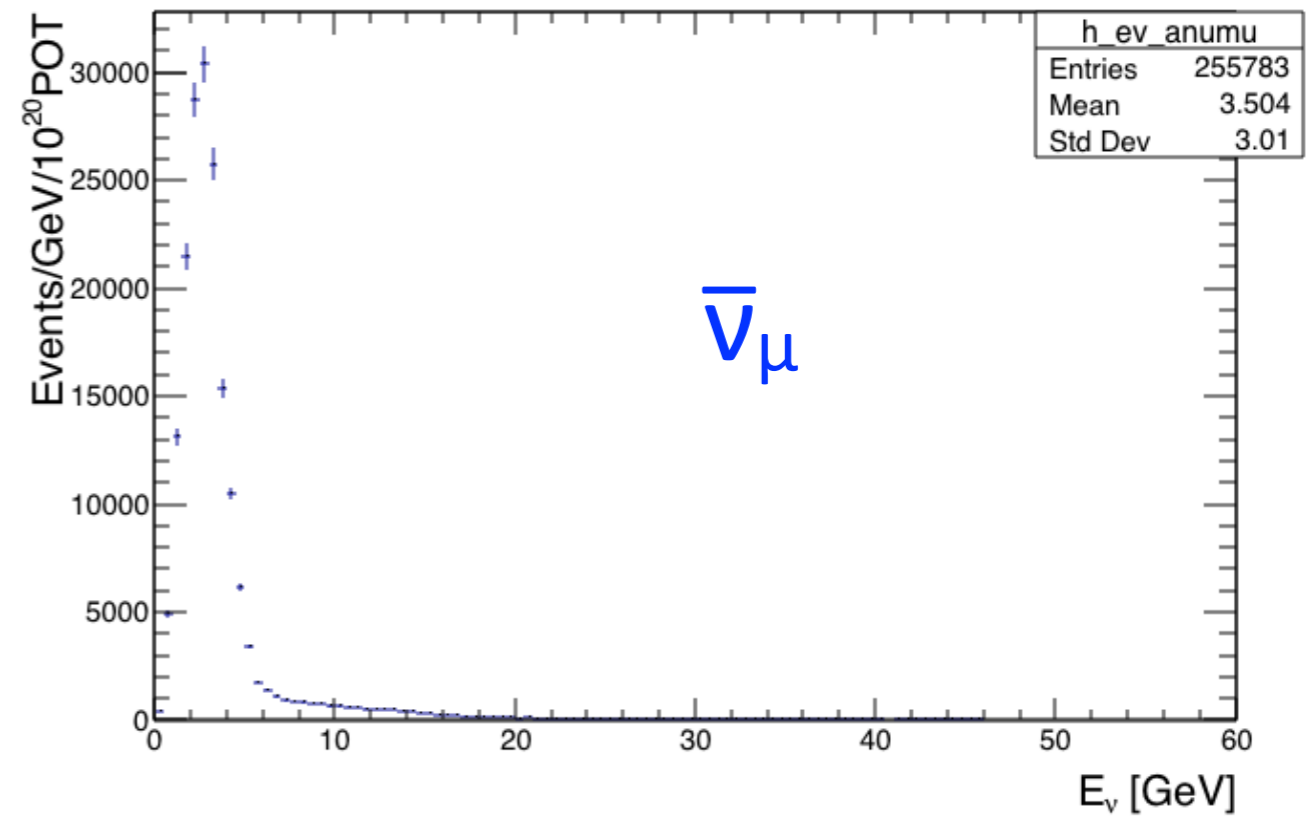
- | | |
|---------------------------------|-----------------------------|
| - genie::EventGenerator/NUE-EL | Elastic electron scattering |
| - genie::EventGenerator/IMD | Inverse muon decay |
| - genie::EventGenerator/IMD-ANH | |

Quality checks

Weighted events per 10^{20} POT



**Neutrino mode
(FHC)**



**Antineutrino mode
(RHC)**

Interaction rates on KLOE

Findings and Action Items
From
The 3rd DUNE Near Detector Workshop
CERN, 6-7 Nov 2017

- Answer the “Action Items” from the last ND Workshop
- We (LNS) agreed to answer point 2 of item 3.1:

Participants of the WS agreed that the following questions should be answered and documented for both magnets in a docDB document:

1. KLOE magnet needs to be simulated with STT in DUNEGGD
2. Tabulate statistics in different channels (see appendix) as a function of fiducial mass
3. Evaluate key performance figures as a function of energy (E) and fiducial volume (FV)

- With a special eye on the following key interactions:

Appendix

A. Key interactions

- Neutrino-electron elastic scattering
- Coherent π^0 and $\pi^{+/-}$
- Low ν (250-MeV cut)
- CC Inclusive (electron/muon)
- NC/CC π^0

Interaction rates on KLOE — see attached doc

- Nu_μ events are weighted with ‘neutrino mode’ (FHC) flux,
- Nu_μ^{bar} events are weighted with the ‘antineutrino mode’ (RHC) flux.
- Interaction rate of events in KLOE obtained and tabulated.

- Dedicated production with a liquid Argon cube to compare with numbers reported in the CDR.
- Reproduce the table equivalent with the CDR one, 1m³ of liquid Argon and neutrino flux from —> <http://home.fnal.gov/~ljf26/DUNE2015CDRFluxes/Optimized Beam – 120 GeV, 204m x 4m DP>

- Low-nu interactions to be finalised.

KLOE equivalent mass

- Reference: **CDR 2015 Vol. 4**
- Average density of Fine-Grained Tracker (our case): 0.1 g/cm³
- Geometry of tracking region: radius 2 m, length 3.38 m
- Volume = 42.47 m³, mass = 4.25 t

Table 7.1: A summary of the performance for the FGT configuration

Performance Metric	FGT
Dipole magnetic field	0.4 T
Average target/tracker density	$\rho \sim 0.1 \text{ g/cm}^3$
Target/tracker Volume	3.5m x 3.5m x 6.4m
Target/tracker Mass	8 t
Vertex Resolution	0.1 mm
Angular Resolution	2 mrad
E_e Resolution	5%
E_μ Resolution	5%
$\nu_\mu/\bar{\nu}_\mu$ ID	Yes
$\nu_e/\bar{\nu}_e$ ID	Yes
NC π^0 /CCe Rejection	0.1%
NC γ /CCe Rejection	0.2%
CC μ /CCe Rejection	0.01%